FIRE PROTECTION ENGINEERING ROLES

SFPE Core Competencies

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v1.0

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This document has been developed by the SFPE Standing Committee for Professional Qualifications; specifically by the Subcommittee on Competency and Credentialing.

INTRODUCTION

In December 2018, the Society of Fire Protection Engineers (SFPE) established the "Recommended Minimum Technical Core Competencies for the Practice of Fire Protection Engineering," advancing the SFPE mission to "define, develop and advance the use of engineering best practices; expand the scientific and technical knowledge base; and educate the global fire safety community, to reduce fire risk".

Following the publication of the Recommended Minimum Technical Core Competencies, the SFPE Standing Committee for Professional Qualifications, specifically the Subcommittee on Competency and Credentialing, began defining seventeen technical specialties, or "roles", available to fire protection engineers. These roles are intended to further identify the minimum technical knowledge and skills required to perform various tasks within fire protection engineering.

As a discipline with global relevance and impact, fire protection engineering provides diverse opportunities for those committed to protecting lives, property, and the environment from the devastating effects of fire. These professionals apply their specialized skills and knowledge across numerous industries and sectors. These technical specialties emphasize the broad range and significance of fire protection engineering skills in today's complex and ever-changing world.

It is important to note that fire protection engineers may possess knowledge or competency in multiple defined roles, allowing them to adapt and excel in various professional environments. This interdisciplinary approach further underscores the value and flexibility of fire protection engineering, enabling these professionals to make significant contributions to safety and risk reduction across diverse sectors.

Note: *The term "fire protection engineer" should be viewed as synonymous with the terms "fire safety engineer" and "fire engineer." These terms apply to the application of engineering principles to prevent and mitigate the unwanted impact of fire. For practical purposes, only the term "fire protection engineer" is used in the remainder of this document.*

USING THIS DOCUMENT

This document provides an overview of the different technical specialties or "roles" available to fire protection engineers, as defined by the Society of Fire Protection Engineers (SFPE). Each role is presented in a standardized format, which includes the following sections: Scope, Overview, Competencies, Stakeholders, and Common Activities.

SCOPE

Outlines the specific minimum competency for a given role, identifying the essential knowledge base, engineering principles, and practical applications related to that area. It also specifies any limitations or exclusions within the scope of the role.

OVERVIEW

Provides a brief summary of the role, discusses its importance in fire protection engineering and the key concepts or objectives it addresses. It is intended to give readers a general understanding of the role and its significance in the field.

COMPETENCIES

Lists the essential knowledge and skills that a fire protection engineer should possess to effectively perform the duties associated with the role. These competencies are derived from the SFPE's Core Competencies and may include technical knowledge, engineering principles, and practical skills related to the specific role.

STAKEHOLDERS

Identifies the various parties involved in or affected by the work of fire protection engineers within the role. Stakeholders can include other professionals, organizations, or authorities that play a part in the design, implementation, or regulation of fire protection systems or practices.

COMMON ACTIVITIES

Outlines the typical tasks and responsibilities that fire protection engineers might encounter while working within the role. These activities can vary based on the specific role, but generally represent the core functions associated with the position.

By organizing each role in this consistent format, readers can easily understand the unique aspects and requirements of each role in fire protection engineering. It can serve as a valuable resource for both aspiring and experienced fire protection engineers, helping them identify the minimum core competencies necessary for the roles that best align with their interests, skills, and career goals. Additionally, the fire protection engineering roles can be used by employers, educators, and other stakeholders to better understand the knowledge required for the minimum technical competency for each individual role within the field of fire protection engineering.

FIRE PROTECTION ENGINEERING ROLES

SFPE has identified the following specific roles within the fire protection and fire safety engineering field. Detailed scope documents for roles shown in gray are in progress and will be released for public comment in the future.

CLEAN AGENT SUPPRESSION

Fire suppression through chemical interference with combustion or oxygen displacement via gaseous flooding of the volume containing a fire incident

EXPLOSION PROTECTION

Prevention, protection, or mitigation of dust, gas, vapor, and mist detonation or deflagration

FIRE ALARM & DETECTION

Fire detection, occupant notification, and emergency communication systems

FIRE PROTECTION & LIFE SAFETY MODELING

Predictive simulation of fire and smoke spread and viability of egress and ingress routes

FORENSIC FIRE ENGINEERING

Fire cause analysis; fire loss analysis; fire protection system design, installation, performance, defect and failure analysis (fire and non-fire related); and fire/life safety construction defect analysis

GOVERNANCE OF FIRE PROTECTION

Creation and application of regulations to fire protection and their impact on engineering methods and solutions

HUMAN BEHAVIOR

Communication methods with occupants during emergencies and expected actions in response to fire and other emergencies

MEANS OF EGRESS

Design of buildings and other structures with regard to egress pathways and related strategies during fire or other emergencies

PASSIVE FIRE PROTECTION

Non-active fire safety systems for the containment of combustion products, evacuation allowance, and limitation of fire and smoke consequences

PERFORMANCE-BASED DESIGN

Analytical techniques to develop non-prescriptive fire engineering solutions to address stakeholder objectives

PROCESS FIRE SAFETY

Loss of Containment (LOC) and management techniques to mitigate chemical/hydrocarbon fires

FIRE RISK ASSESSMENT

Analysis of aggregate consequences and probability regarding fire incident loss potentiaL

SMOKE CONTROL SYSTEMS

Management and mitigation techniques to control smoke by natural or mechanical means

SPECIAL HAZARD SYSTEMS

Hazard protection using CO2, dry, wet chemical, or hybrid suppression systems

STRUCTURAL FIRE PROTECTION

Fire exposure impact on structural elements, with regards to fire resistance qualification, fire resistance equivalency, and structural fire engineering

WATER-BASED SUPPRESSION SYSTEMS

Hazard protection using water-based sprinklers, foam, or mist suppression systems

WILDLAND URBAN INTERFACE

Planning, response, and recovery strategies in response to Wildland Urban Interface (WUI) fires

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MEANS OF EGRESS

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SCOPE

This document identifies fundamental principles, design criteria and evaluation methodologies for the means of egress based on hazard and occupancy. The ability to utilize both prescriptive and performance-based techniques, incorporation of the impact of behavioral response to emergencies, are important concepts that should be known and utilized by engineers.

OVERVIEW

Developing means of egress systems incorporates both prescriptive and performance-based approaches. Applying the concepts of phased or full evacuation and the techniques of occupant discharge from a building/area compared with occupant relocation within a building and the use of areas of refuge are distinct strategies for occupant evacuation.

With a performance-based design approach, applying both fire and egress simulations, and understanding the fundamental concepts of those techniques, including behavioral response to establish a means of egress design. Fire and egress simulations are regularly applied together as a cohesive analysis for the successful application of a performance-based means of egress design.

STAKEHOLDERS

- Authorities Having Jurisdiction
- Fire Protection Engineers
- Architects
- Building Owners
- Building Managers

COMPETENCIES

- Identification and analysis of hazards
- Knowledge and identification of occupancy categories and prescriptive requirements, such as:
    - Crowd management
    - Occupant load
    - Egress capacity
    - Required number of exits
    - Travel distance limitations
        - To exits
        - Common paths
        - Dead ends
    - Remoteness/separation of exits
    - Requirements by component
        - Stairs
        - Ramps
        - Corridors
        - Doors
        - Pathway illumination
        - Pathway marking/signage

- Identify performance-based analysis opportunities, such as:
  - Application of timed egress and behavioral models
  - Model assumptions
  - Incorporation of pre-movement time and other elements of human behavior
  - Incorporation of security features
  - Incorporation of the impact of people with disabilities and associated building features
  - Model limitations
  - Acceptable performance criteria
    - Visibility
    - Heat
    - Toxins
  - Modeling the effects of fire on the environment to evaluate performance criteria
  - Apply mitigation techniques, if needed, and iterate through the analysis

COMMON ACTIVITIES

- Research and interpret prescriptive requirements to apply nuances of the code and with the understanding of code intent.
- Develop conceptual approaches to evaluate means of egress by either code based or performance-based techniques.
- Defend the safety and efficacy of the egress concepts.
- Apply performance-based techniques to evaluate means of egress design options.
- Provide peer review or technical review of analyses with the understanding of the complexities of various approaches:
  - Basis of the code(s)
  - Model assumptions
  - Model limitations
  - Model output.
- Evaluate and provide feedback regarding the implementation plans of signage, emergency lighting and notification systems with regards to their impact on egress.

SMOKE CONTROL

FIRE PROTECTION ROLES | SFPE CORE COMPETENCIES

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SCOPE

This document identifies the knowledge base of principles and expertise required to establish recognized competency in the subject of smoke control, particularly with respect to building occupants and high value assets. The domain of this guidance includes requisite knowledge of general fire protection and fire science principles directly related to smoke, as well as an in-depth understanding of the application of management and mitigation techniques to control smoke by natural and mechanical means using air movement.

OVERVIEW

Smoke control can be described as methods and mechanisms that prevent, reduce, or limit the amount of smoke occupants come in contact with from a fire event. A smoke control system can be considered to be an engineered system that includes all methods that can be used singly or in combination to modify smoke movement.

COMPETENCIES

Core competencies in smoke control consist of demonstrable knowledge and skill in the following subject matters and their interrelationships:

Smoke Control	
Core Competence	**Knowledge Level**
Planning & Design	Apply & Evaluate
Relevant Criteria	Apply
Operation	Apply & Evaluate
Interface	Apply & Evaluate
Inspection & Acceptance	Apply & Evaluate

Smoke Clearance	
Core Competence	**Knowledge Level**
Planning & Design	Apply
Operation	Apply
Inspection & Acceptance	Apply & Evaluate

Pressure Differential	
Core Competence	**Knowledge Level**
Planning & Design	Apply & Evaluate
Inspection & Acceptance	Apply & Evaluate

A competent engineer working in this role should be capable of demonstrating requisite knowledge in the following related areas:

- Compartment Fire Dynamics
  - Fire development (i.e., growth, flashover, full development, and decay)
  - Heat release rate (HRR)
  - Design fires
  - Ventilation (fire-development related)
  - Impact of active and passive mitigation features (i.e., effects of sprinklers on HRR decay and activation time)
- Plume Dynamics
  - Factors governing smoke production (i.e., air entrainment, turbulence)
  - Plume types (i.e., axisymmetric, spill)
  - Smoke stratification
  - Smoke movement (i.e., plume flow, buoyancy, stack effect, wind effect, expansion)
  - Exhaust and makeup air
- Risk & Hazard Analysis
  - Establishing stakeholder objectives
  - Hazard identification
  - Risk assessment (qualitative and quantitative)
  - Safety margin
- Knowledge of Calculation/Evaluation Methodology
  - Validity of real-life events and experiments
  - Criteria used in evaluation method selection
  - Calculation tools
  - Limitations of methodology
  - Knowledge of drivers for when which evaluation tools are warranted (e.g., the complexity of plume dynamics is beyond the application of hand calculations and warrants the use of Computational Fluid Dynamics)
- System Design
  - Mechanical systems & components (i.e., exhaust type, orientation, and location; makeup air)
  - Natural systems & components (i.e., exhaust type, orientation, and location; makeup air)
  - External factors (i.e., wind, building height, built environment)
  - Refuge and zone control
  - Interaction with building facilities (i.e., fire alarm, HVAC, lighting, security access)
- Occupant egress
  - ASET versus RSET framework
  - Human behavior (i.e., behavioral indicators influenced by sex, age, race, group dynamics, cognitive abilities, focal point, familiarity with surroundings, and alertness level)
  - Tenability including exposure impact & limits (i.e., toxic gases [FED], exposure to heat (radiative and convective), visibility (obscuration)
  - Occupant movement (i.e., premovement time, walking speeds, specific & effective flow, the effect of high- /low-density escape (distance versus queuing dominant flow)
- Emergency personnel ingress
- Knowledge of local codes and alignment with smoke control objectives, design integration and expectations, performance, and design

STAKEHOLDERS

- Authorities Having Jurisdiction
- Fire Protection Engineers
- Mechanical Engineers
- Codes & Standards Developers

COMMON ACTIVITIES

- Design Basis & Planning, including:
  - Containment (space pressurization and zone control) and,
  - Management (natural fill of unoccupied volume, dilution, mechanical exhaust, and venting to maintain smoke layer interface and to slow rate of smoke descent to allow egress and opposing airflow to prevent movement across a space boundary).
- Evaluate the impact of diverse factors pertinent to the design, including:
  - Weather effects
  - Pressure differences across space boundaries
  - Source location
  - Movement and airflow, and
  - Interface with gaseous fire suppression.
- Apply control measures based on boundary conditions and other related factors.
- Evaluate egress analysis to determine tenability requirements (e.g., RSET, minimum smoke layer depth).
- Compare engineering analysis to design concept results to establish the suitability of design to meet tenability requirements.
- Implement and defend proposed solutions to achieve required smoke control and related systems.
- Ensure proper interoperation of smoke control systems with other support systems, including alarm systems, egress pressurization systems, area of refuge protections, ingress paths to fire fighters' control points, and alternate power systems.
- Assist with commissioning, special inspection, and acceptance by Authorities Having Jurisdiction, including planning, testing, and reporting.

STRUCTURAL FIRE PROTECTION

FIRE PROTECTION ROLES | SFPE CORE COMPETENCIES

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SCOPE

This document outlines the necessary knowledge base, engineering principles, and expertise required for comprehending the impact of fire exposure on structural elements, utilizing either the prescriptive compliance method or structural fire engineering approach.

OVERVIEW

Structural Fire Protection generally consists of three different approaches:

1. Fire Resistance Qualification
2. Fire Resistance Equivalency
3. Structural Fire Engineering

The prescriptive compliance method relates to the qualification and prescription of structural fire protection as measured by the level of fire resistance, including the understanding of fire testing qualification, equivalence calculations per fire testing and its specific acceptance criteria, and explicit simulation of fire testing (if permissible). Structural fire engineering relates to the explicit design of structural systems to adequately endure thermal load effects from structural design fires based on specific performance objectives. This alternative method requires participation by a structural engineer.

The role of fire protection engineers and the technical competencies necessary for each aspect of structural fire protection are described herein. For a given application, the fire protection engineer identifies the applicable method per Figure 1.

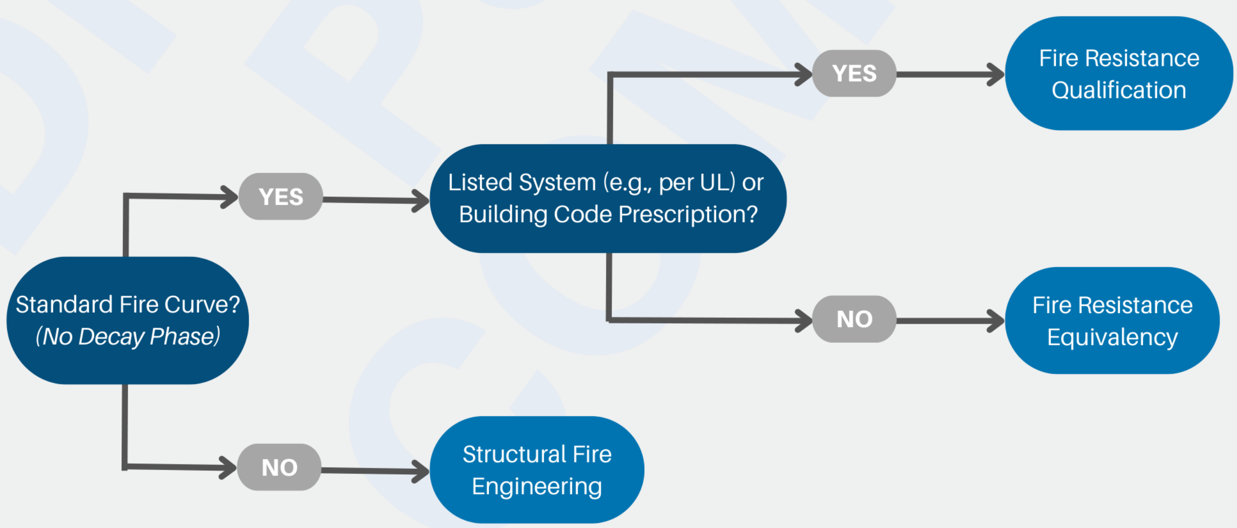

Figure 1: Applicable Structural Fire Protection Method

STAKEHOLDERS

- Structural Engineers
- Fire Protection Engineers
- Architects
- Authorities Having Jurisdiction
- Codes & Standards Developers

FIRE RESISTANCE QUALIFICATION | COMPETENCIES

Fire Resistance Qualification is achieved with generally accepted solutions by the applied regulation based on long-standing fire engineering experience and testing (e.g., per ASTM E119 [1] or similarly EN 1363 [2]) or with the application of non-bearing external protective layers based on standardized fire testing.

Fire safety regulations often offer generally accepted solutions for the definition of the available fire resistance of a building element, i.e., a minimum thickness of a brick wall that is generally accepted to have 30 minutes of fire resistance. This generally accepted prescriptive solution is offered as a general and conservative solution without requiring structural fire engineering calculations.

Engineers performing Fire Resistance Qualification must have the necessary understanding to apply the abovementioned solutions based on product certifications, results of standard tests, and generally accepted prescriptive solutions. As long as the proposed solution does not require structural fire engineering calculations or understanding the structural response of the building element in fire, Fire Resistance Qualification is a solution to determine the fire resistance design.

FIRE RESISTANCE QUALIFICATION | COMMON ACTIVITIES

- Recognize building elements that require a fire-resistance rating.
- Recognize if a building element is bearing or non-bearing as it pertains to its required fire resistance rating.
- Employ the appropriate standardized furnace test method to qualify the required fire-resistance of the building elements and understand the limitations of their application.
- Recognize the technical directions of the fire resistant system provider.
- Assess appropriate fire-resistant systems to satisfy the required fire-resistance rating of each building element based on the declarations of conformity of the designers, builders, and providers when local regulations require this.
- Recognize the limitations of the Fire Resistance Qualification method.

FIRE RESISTANCE EQUIVALENCY | COMPETENCIES

Fire Resistance Equivalency is achieved by demonstrating that a fire resistance assembly would achieve equivalent or better performance during a standard fire test compared to a similarly qualified assembly. This method is limited to consideration of furnace heating exposure (which has no decay phase) and standard fire test acceptance criteria. [3]

Competency in the area of Fire Resistance Qualification must also be achieved. Engineers performing Fire Resistance Equivalency must have the necessary understanding to conduct the thermal aspects of Fire Resistance Equivalency. Structural aspects of this method would only pertain to the structural response of a mock-up assembly under standard fire test conditions.

FIRE RESISTANCE EQUIVALENCY | COMMON ACTIVITIES

- Evaluate all aspects of the Fire Resistance Qualification method.
- Appraise relevant heat transfer phenomena within a standard fire test.
- Identify thermal boundary conditions from the furnace heating exposure.
- Formulate temperature-dependent thermal properties of structural and protective materials.
- Assess the thermal response of structural members and components based on standardized furnace test conditions.
- Determine the structural limitations of standardized furnace test conditions.
- Identify and interpret the limitations of the Fire Resistance Equivalency Method.

STRUCTURAL FIRE ENGINEERING | COMPETENCIES

Structural Fire Engineering is achieved by demonstrating a structural system's strength and stability to resist project-specific design fires, considering factors such as fuel load and compartmentalization. [4] Structural design fires assume no control from fire suppression systems or manual intervention. A heat transfer analysis quantifies the temperature history of structural members, followed by a structural analysis to evaluate system response and stability per ASCE 7 or EN 1990 standards [5]. This considers forces induced by restrained thermal expansion and material property degradation.

Competency in Fire Resistance Qualification and Equivalency is also required. Engineers conducting Structural Fire Engineering must understand developing structural design fires and determining the thermal response using heat transfer calculations. Structural analysis of fire-exposed members should be conducted by a qualified structural engineer.

STRUCTURAL FIRE ENGINEERING | COMMON ACTIVITIES

- Recognize and define structural design fire scenarios that bound conceivable ventilation and compartmentation conditions considering differing and uncertain environmental aspects of the building spaces.
- Assess and apply design fuel loads to an appropriate fire dynamics calculation method.
- Define and assess thermal boundary conditions from structural design fires.
- Formulate temperature-dependent thermal properties of structural and protective materials.
- Evaluate the thermal response of structural members and components based upon thermal boundary conditions from structural design fires.
- Recognize structural boundary conditions and define the scope of the structural analyses
- Recognize the relevant loads acting on the structural system.
- Assess the design loading level based on the required load combinations of the applied structural regulations.
- Formulate temperature-dependent mechanical properties of structural materials.
- Evaluate appropriate structural performance criteria for the analysis and the appropriate engineering methods for the structural calculations.
- Appraise appropriate structural models that can account for the relevant structural responses.
- Assess and judge the structural system response by tracing all structural loads to ground while accounting for all structural limit states, potential modes of instability and any second-order phenomena.
- Assess and judge global and local structural system capacities and employ the appropriate margins of safety for various potential failure modes.
- Compare the results of structural analyses with performance criteria and evaluate the margins of safety.
- Justify and defend the structural analyses and the underlying parameters impacting the severity of fire exposure to a controlling body of structural engineers with a similar level of rigor and liability as for other structural loads.

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